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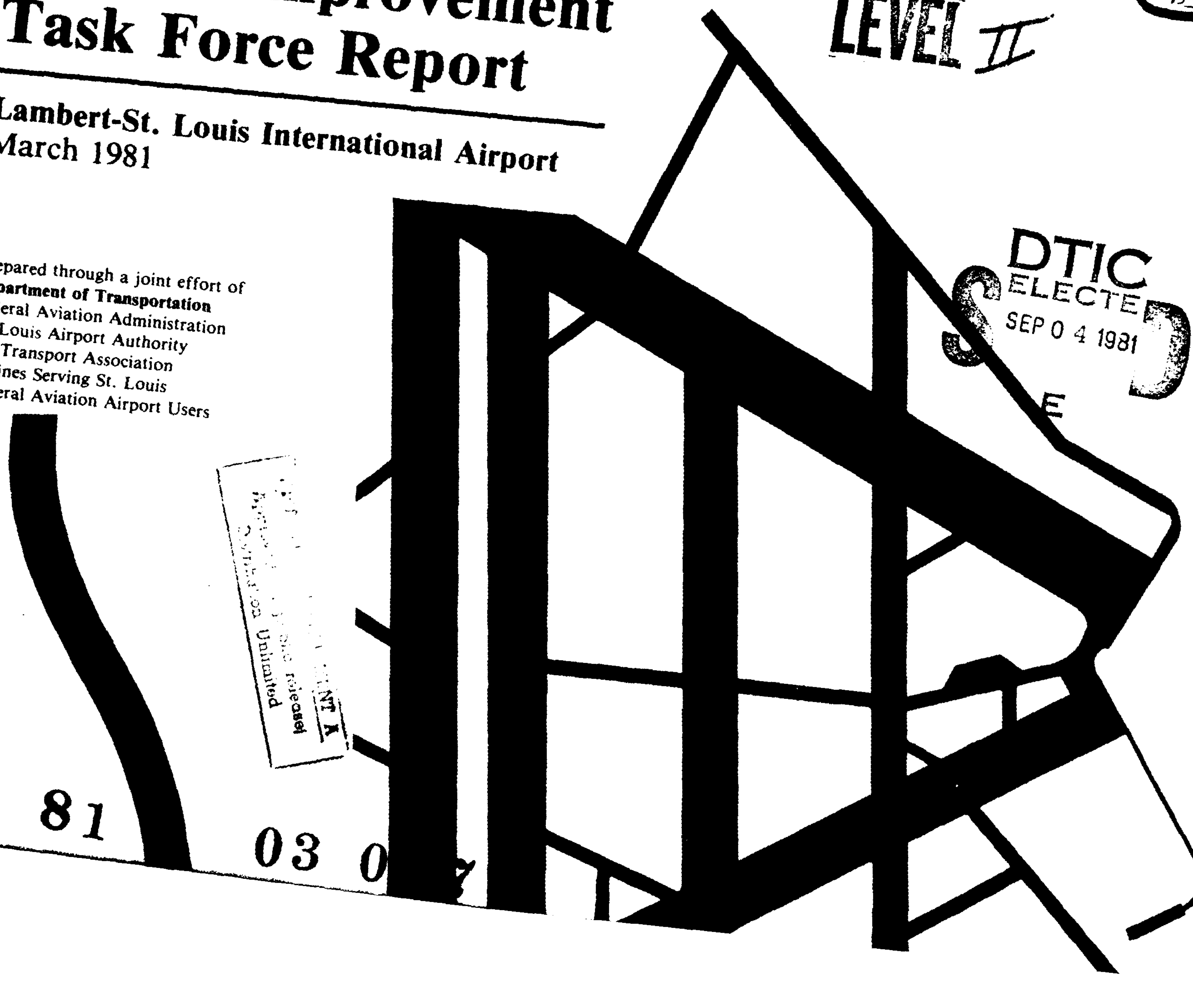
# Airport Improvement Task Force Report

**Lambert-St. Louis International Airport**
March 1981

Prepared through a joint effort of
**Department of Transportation**
Federal Aviation Administration
St. Louis Airport Authority
Air Transport Association
Airlines Serving St. Louis
General Aviation Airport Users



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16. Abstract

This report presents the results of a detailed analysis of the Lambert-St. Louis International Airport. The analysis was conducted by the Lambert-St. Louis Airport Improvement Working Group which had representatives from the airport sponsor, the Air Transport Association, the airlines serving St. Louis, and the Federal Aviation Administration. The purpose of the analysis was to determine the causes of delay and the potential delay reduction benefits of recommended improvements. The effort was part of the Airport Improvement Program.

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# Preface

This study of causes and potential solutions to *air traffic* delays at Lambert-St. Louis International Airport has identified a comprehensive program of delay reduction measures which, if implemented, has the potential to dramatically reduce aircraft delays and their costs.

The study was conducted from 1978 through 1980 by a Task Force composed of representatives of the Federal Aviation Administration (FAA), the St. Louis Airport Authority, the airlines serving St. Louis, the Air Transport Association, and other Airport users. The FAA provided technical support from its Washington headquarters staff and consultant support from Peat, Marwick, Mitchell & Co. The Missouri-St. Louis Metropolitan Airport Authority provided technical and financial support toward the preparation of this report.

The study has resulted in 11 specific recommendations for improvements to Lambert-St. Louis International Airport. Task Force members plan to continue to meet as necessary to assist in the *implementation of these recommendations and* to provide a forum for the identification and assessment of further improvements.

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# Introduction

## Background

In recent years, increases in aviation demand, together with wake vortex separation standards, have produced significant increases in delay and delay-related fuel consumption at the nation's airports.

The development of new metropolitan airports to augment system capacity and reduce delay is difficult and costly, as is the incremental expansion of existing facilities. It has become clear that to continue providing satisfactory air transportation service, the aviation industry must concentrate on achieving the highest efficiency of the existing airport system. To accomplish this and to identify future requirements in practical terms, quantitative performance data for major airports are needed. Such data permit wise management decisions on (1) optimum airport use strategies; (2) expenditures for runways and other facilities and equipment; and (3) research and development priorities.

The establishment of a local Task Force in St. Louis was an outgrowth of Federal Aviation Administration (FAA) and Air Transport Association (ATA) concern about capacity and delay at the nation's major airports. A 1974 FAA report on airport capacity furnished considerable insights to capacity-related operational problems at eight of the country's major airports; however, it was decided that the findings should be evaluated by the persons directly involved in the operation and use of the airports. Therefore, in late 1974, the FAA established an ad hoc working group with the primary purpose of developing an action plan to reduce airport delays and to identify development options for implementation or further study at eight major airports. It was anticipated that recommendations developed jointly would form a basis of support for individual management decisions by each participating group. The net result of these joint recommendations was envisioned to be a coordinated series of further actions whose combined effect would be to reduce delay substantially.

As the studies at the eight airports neared completion, it was determined that an additional number of airports should be included as a second group in the program. Lambert-St. Louis International Airport was selected as the first airport to be studied in the second group, because aircraft delays at Lambert-St. Louis International Airport have grown significantly over the past few years (4,500 aircraft hours and over 300,000 passenger hours in 1979). By 1990, delays could reach ten times these amounts, assuming tht the airfield configuration is as it was in 1979.

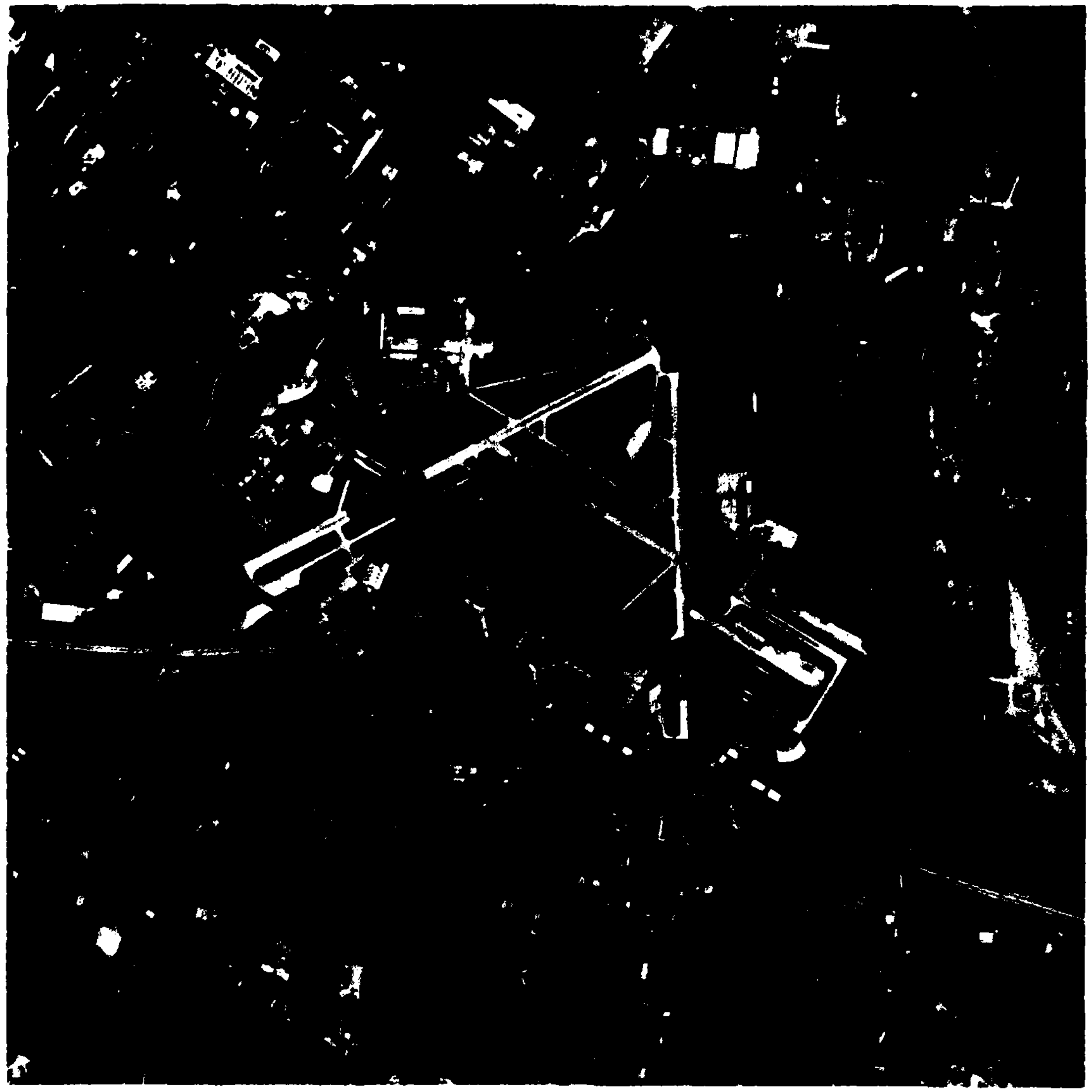
In St. Louis, complementary studies have recent-

ly been completed that have been of value to the Task Force members. These include an airfield development program study, which recommended extensions of Runways 12L-30R and 12R-30L, and numerous taxiway system improvements. An environmental assessment study was also undertaken of the airfield development program. This study now stands as an FAA-approved environmental impact statement.

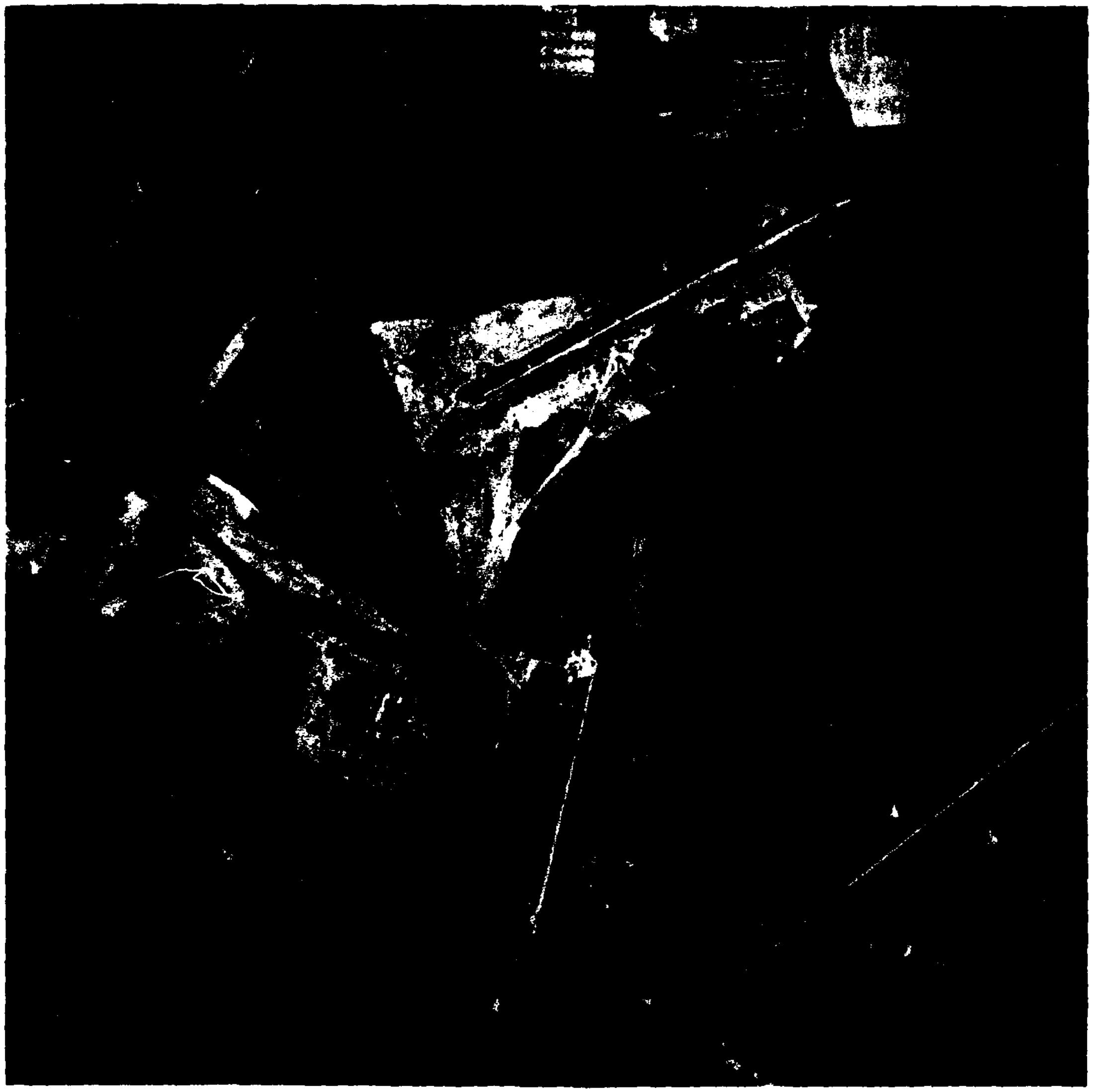
The Airport Authority is now sponsoring an Airport Environs Study, designed to improve compatibility between the Airport and its surrounding communities and to protect against increased enroachment.

Additionally, a study was undertaken of facility operations of the St. Louis air traffic control tower and the Kansas City air route traffic control center (ARTCC) by personnel from these facilities. This study was intended to supplement the Task Force work. It focused on problems within the Kansas City ARTCC East Area airspace below 18,000 feet mean sea level and within the St. Louis approach control area. Some of the recommendations of this study are annotated in this report. Significant delay reductions have been identified in this study. Some changes have been made, some are being implemented, while others will require extensive adjustment of procedures and equipment.

The objectives, scope, and methodology of the Task Force study are summarized below. The key recommendations of the Task Force and information on supporting technical studies are presented on subsequent pages.



Lambert St. Louis International Airport-1979



Lambert St. Louis International Airport 1941

## Objectives

Considering Lambert-St. Louis International Airport's escalating delays and their cost implications, the Task Force agreed on four objectives to guide the analysis of current and future operations. These objectives were:

1. To estimate the potential benefits of reducing aircraft delay through airfield development and air traffic control (ATC) procedures, Airport use policies, and Airport facility developments.

2. To estimate current and future relationships between air traffic demand and aircraft delay as an aid for future planning.

3. To estimate the potential benefits of increased Airport capacity and reduced aircraft delay of proposed improvements in air traffic control systems resulting from the FAA Engineering and Development program.

4. To evaluate Airport capacity and aircraft delay and to identify causes of delay associated with operations in the airspace, airfield, and apron/gate systems.

## Scope

The analyses in this study focused on means of increasing the operating efficiency of the Airport and reducing aircraft delays through changes in air traffic control procedures, changes in Airport use policies, and potential airport development actions.

## Methodology

Potential improvement options were suggested by Task Force members, who also reviewed and approved the operating condition under which each option would be tested. Three levels of aviation demand were used: 1979, post-1985, and post-1990, as detailed later in this report. The post-1985 and post-1990 are intended as general reference to possible short- and long-range traffic growth.

The options were evaluated with the assistance of an airfield simulation model that was validated against real-world data on demand and delay. The model was used to quantify the delay associated with each improvement option. The data resulting from computer runs on the improvements were then compared with data from control or baseline runs to estimate potential reductions in delay.

A second model, the annual delay model, was used to evaluate other options and to quantify the average delays expected at the Airport under various current and future conditions.

The potential benefits of Airport improvement options were estimated in dollar terms. The dollar estimates are intended to indicate the general order of magnitude of the savings and are not intended to be interpreted as exact figures, due to the potential future variations in aviation demand and aircraft operating costs. Savings in passenger time are not included in the estimates.

The Task Force limited its studies to the St. Louis terminal area airspace and the airside of the Airport.

Specific environmental concerns were recognized in developing recommendations, but they were not within the scope of the Task Force study and are not addressed in this report.

# Airport Improvement Recommendations

The Task Force reviewed many potential airport operation options in four categories:

- Airfield development
- Air traffic procedures
- Airport use policies
- Airport facility development

The review of these potential options—including the quantification of benefits, evaluation of operational problems, and consideration of other related matters—resulted in the selection of 11 specific recommended improvements. Brief descriptions of the improvements and estimates of their potential annual savings are shown in Table 1. Details on the individual recommended improvements are given on subsequent pages.

## Airfield Development

Al—Analyze Benefits of the Airfield Development Program
The recently completed airfield development program consists of a 2,500-foot extension of Runway 12L-30R to the east, plus numerous improvements to existing taxiways and construction of new taxiways. In addition, the use of Runway 17-35 south of its intersection with Runway 12R-30L will be discontinued in the future.

## Air Traffic Procedures

**B1—Use Localizer Type Directional Aid (LDA)**
Fully utilized, this improvement would involve the installation of two instrument landing system (ILS) localizer antenna north of the Airport with their beams radiating parallel to the localizer beam for Runways 12R and 30L. Under certain conditions of VFR and instrument flight rule (IFR) weather, aircraft could approach the Airport using the offset localizer beam until they break out under the cloud cover, and then the aircraft would proceed visually to land on Runway 12L or 30R. This landing procedure, in effect, would provide dual arrival streams that would significantly increase Airport capacity.

The analysis of the LDA benefits was conducted under the assumption that the offset approaches would be used when the airfield is being operated in either a westerly or an easterly direction, and benefits of reduced delay are estimated under VFR2 and IFR1 weather conditions (see Table 2 for values). Under post-1985 demand conditions, the average annual delay is estimated at 1.2 minutes per aircraft operation. Under post-1990 demand conditions, the average annual delay is estimated at 4.1 minutes. The post-1990 estimated annual delay cost savings is over $3,000,000.

The LDA is recommended for implementation at. St. Louis.

**B2—Use Runways 6-24, 12L-30R, and 12R-30L Simultaneously**
With Runway 12L-30R extended to 9,003 feet (Option A1), all types of air carrier aircraft

## Table 1

## COST SAVINGS OF AIRPORT OPTIONS
## Lambert-St. Louis International Airport

| Airport option | Annual cost savings related to post-1990 demand |
|---|---|
| **Airfield Development** | |
| Airfield development program | $ 6,000,000 |
| Localizer type directional aid (LDA) | 3,000,000 |
| **Air Traffic Procedures** | |
| Use Runways 6-24, 12L-30R, and 12R-30L simultaneously | 12,000,000 |
| Departure fanning | 9,000,000 |
| Future ATC system | 14,000,000 |
| Improve Center/Tower operations | Benefits not quantified by Task Force |
| **Airport Use Policies** | |
| Increase use of heavy jets | $ 2,000,000 |
| Decrease use by low performance aircraft | |
| 25% reduction | 10,000,000 |
| 50% reduction | 18,000,000 |
| Improve airline scheduling | Benefits not quantified by Task Force |
| **Airport Facility Development** | |
| Expand passenger terminal building | Benefits not quantified by Task Force |
| Relocate Midcoast Aviation | Small benefits in airfield operation |

NOTES:
1. Benefits of the airfield development programs are estimated in relation to the 1979 airfield. Benefits of other options are estimated in relation to the airfield development program.
2. Benefit estimates are not additive. The combination of two or more options would produce less than the sum of the independent options.
3. Benefit estimates are based on an assumption that an aircraft "fanning" procedure is in effect on all aircraft departures, when the parallel runways are in operation.

The extension of Runway 12L-30R provides a total runway length of 9,003 feet, thus permitting it to be used by all categories of air carrier aircraft. Under visual flight rules (VFR) weather conditions, dual simultaneous air carrier aircraft arrival and departure streams will operate on the two parallel runways, and the large and heavy categories of aircraft can be assigned to either runway.

By the post-1985 time period, the airfield development program will provide a reduction of 0.3 minute of average annual delay (1.7 minutes for the 1979 airfield and 1.4 minutes for the airfield development program). This is an 18% reduction. The same comparison for the post-1990 time period results in a 0.9 minute average delay reduction (5.4 minutes versus 4.5 minutes).

The post-1990 dollar value of the savings is over $6 million annually.

expected to be scheduled to the Airport in the future could use that runway. When wind and weather conditions permit the use of Runways 6-24, 12L-30R, and 12R-30L simultaneously, the capacity of this three-runway use pattern is substantially higher than that of the parallel runways alone.

For example, in the west flow configuration, Runways 24 and 30R could be used by all types of arrival aircraft and Runway 30L could be used for departures.

This procedure is especially beneficial in IFR1 conditions (see Table 2) and during periods when aircraft arrivals are greater than departures, because this procedure permits essentially two independent arrival streams. An analysis of wind data revealed that Runways 6-24, 12L-30R, and 12R-30L could be used simultaneously up to about 90% of the time. Therefore, if the pattern of runway use was changed from a predominantly two-runway configuration today to a predominantly three-runway configuration in the future, annual aircraft delays could be expected to decrease significantly.

Results of the annual delay model analysis show that average annual aircraft delays would be reduced from 1.4 minutes to 1.3 minutes in the post-1985 time period and from 4.5 minutes to 2.8 minutes in the post-1990 time period. This reduction represents a savings in annual delay costs of $12,000,000 in the post-1990 time period.

The Task Force recommends that the three-runway use pattern be implemented whenever

possible. It is recognized that environmental impacts must be considered in establishing new procedures.

**B3—Use of Departure Fanning**

Normally at the airport, aircraft departures on a given runway must be held for takeoff clearance until the previous departing aircraft, climbing straight out, has reached an altitude 1,500 feet above the ground level. As an alternative during periods of high levels of departure demand, the Air Traffic Control Tower issues orders for the aircraft to turn immediately after takeoff. This procedure, called fanning, permits earlier takeoff clearance for a subsequent departure and results in less delays for departing aircraft. However, fanning does place aircraft in areas not previously utilized and environmental impacts are a factor of consideration.

The procedure that was analyzed involves fanning of departures on both of the parallel runways. With this procedure in effect, average annual aircraft delays are estimated at 0.9, 1.3, and 4.5 minutes for 1979, post-1985, and post-1990 time periods. Without fanning, the comparable figures are 1.1, 1.8, and 5.7 minutes.

After the effect of this procedure was studied, some Task Force members suggested that the noise abatement procedure be modified so that departures during non-peak periods are only required to fly straight out to the Airport boundary before making their turns, and that aircraft turn immediately during the departure peak period. These practices were assumed in assessing the delay factors.

The results indicate that the noise abatement procedure would increase the average peak hour departure delays in 1979 from 2.0 minutes to 7.6 minutes and the average daily departure delays in the peak month from 1.2 minutes to 4.4 minutes. If the noise abatement procedure is applied to Runway 12R only, the increase in departure delays would be smaller.

The effect of the noise abatement procedure on annual delays was also analyzed. This procedure causes an increase in average annual delay of 1.2 minutes per aircraft in the post-1990 period. This increase is equivalent to about $9 million in additional delay costs to aircraft.

The fanning procedure is recommended to be implemented to the fullest extent reasonable. Similar procedures have been established at other airports with full consideration given to environmental impacts.

**B4—Implement Future Air Traffic Control (ATC) Systems**

This option would involve the use of ATC systems that are being developed as part of the FAA Engineering and Development (E&D) Program.

Task Force studies use the air traffic control operating parameters of these programs as given in the FAA report, "Parameters of Future ATC Systems Relating to Airport Capacity/Delay" (FAA-EM-78-8A), June 1978. Accordingly, the standard minimum IFR arrival/arrival separations were reduced from 3 nautical miles (nm) today to 2.5 nm in the post-1990 time period. The largest minimum arrival/arrival separation, e.g., for a small aircraft operating behind a heavy aircraft, was reduced from 6 nm today to 3.5 nm in the post-1990 time period. The minimum departure/departure separation, which today ranges from 1 to 2 minutes, was reduced to 1 to 1.5 minutes in the post-1990 time period.

With these reduced separations, the post-1990 average annual delay is estimated at 2.6 minutes, compared to 4.5 minutes with only the airfield development program in place. This would result in an annual delay cost saving of $14,000,000 under post-1990 demand conditions.

The current FAA program is described in a more recent document entitled "Capital Investment Analysis—For The Coming Decade," October 22, 1980. The estimates of improvements described in that document are discounted from those in FAA-EM-78-8A.

The Task Force supports the expeditious development of these systems and implementation at Lambert as soon as available.

**B5—Air Traffic Delay Study Group Report**

The St. Louis Tower/Kansas City Center Delay Study Group evaluated the interactions between aircraft demand, facility and equipment configurations, and air traffic management. The following are the Study Group's key recommendations to enhance the air traffic system:

- Develop and implement an airspace reorganization plan (both enroute and terminal) that reduces airspace complexity and congestion, thus increasing system capacity and reducing delays.

- Stress to airline management that trip scheduling is an integral element of the ATC system delay problem. The compacted demand produced by scheduling is, at times, physically impossible to accommodate without some aircraft incurring delays.

- Modify clearance delivery procedures to reduce frequency congestion on ground control and allow the clearance delivery controller to meter the flow of departure aircraft to the ground controller.
- Balance delays equitably between IFR/VFR and high/low altitude arrivals.

- Form a joint snow removal committee comprised of Airport management, airlines, and FAA/ATC personnel to develop priorities and operational procedures for an efficient snow removal program.

- Assume a portion of Scott AFB airspace to accommodate a proposed St. Louis Tower internal airspace realignment plan.

- Formulate methods to reduce or eliminate departure delays caused by frequent enroute restrictions. Determine the feasibility of rerouting aircraft to circumnavigate saturated airspace.

- Refine the Kansas City Center arrival metering procedures to provide a more efficient flow of arrival traffic to St. Louis.

- Refine arrival fix balancing to equitably distribute workload between the north and south arrival controller positions.

- Authorize one additional operating position for the St. Louis Tower.

- Improve local control techniques by concentrating on reducing missed departure gaps, decreasing divergent departure headings, applying radar separation behind heavy jets rather than time separation, using all runways to the maximum extent possible, and applying anticipated separation to a greater degree.

- Improve runway utilization by segregating departures, based on direction of flight, to *different runways.*

## Airport Use Policies

**C1—Increase Use of Heavy Jets**
In this improvement option, the airlines would increase their use of heavy jet aircraft, especially the L-1011 and DC-10. The airlines could then enplane more passengers per flight, on the average, and fewer aircraft operations would be needed to carry a given number of passengers.

For the post-1985 time period, increased use of heavy jets (26% of total peak hour air carrier operations versus 15% for a base case) results in an annual delay of 1.7 minutes. For the post-1990 time period, the annual delay is estimated at 4.6 minutes (37% heavy jets versus 24% for a base case). The delay reduction benefits, in relation to the airfield development option only, amount to $2,000,000 per year in the post-1990 time period. In addition, the airlines would achieve reductions in aircraft operating costs from the use of fewer aircraft.

The Task Force recommends that airlines endeavor to increase the average seats per aircraft operation at St. Louis.

**C2—Decrease Low-Performance Aircraft Activity During Peak Operation Periods**
In this option, the Airport could encourage low performance aircraft to use satellite airports by adopting certain management policies (such as increasing landing fees to a level commensurate with the actual cost of operations), thereby reducing general aviation activity. The remaining general aviation activity may consist of only those that must use the Airport, such as aircraft that are carrying passengers who are transferring to air carrier flights and those requiring facilities which are not available elsewhere. The new management policies should be focused on aircraft with approach speeds which are appropriate to the procedures established. Airport capacity should increase and fewer aircraft delays should occur.

Three cases of reduced low performance general aviation aircraft were analyzed involving reductions of 25%, 50%, and 75% from the base case. (The forecast base case levels of general aviation are presented subsequently in Table 3.) The 25% reduction would result in 1.1 minutes annual average aircraft delay for the post-1985 time period and 3.4 minutes for the post-1990 time period. The 50% reduction would result in 0.9 minute and 2.4 minutes delay, respectively, for the two time periods. The 75% reduction would provide only small further reductions in delay.

Compared with the airfield development program option alone, a 50% reduction in general aviation activity would produce an annual delay reduction benefit of $18,000,000 in the post-1990 time period.

The Task Force recommends that Airport management take steps to reduce activity levels of low-performance aircraft during the peaks of activity by transport type aircraft. This includes encouragement of a metropolitan area airport system and of increased capacity of reliever airports.

**C3—Improve Airline Scheduling**
The Tower/Center study reviewed the current schedules of the airlines to determine whether delay reductions could be achieved by changing schedules. The study found that:

> Scheduling practices and associated preferred routings have inherent delays beyond the short-term resolution prerogatives of air traffic control. For example, the eastbound Troy departure gate bottleneck has long been identified as a major source of delay, but little, if any, action has been taken to avoid this routing during peak departure periods. It is not uncommon to observe 10 airline aircraft belonging to the same company taxi virtually at the same time. If flow restrictions permitted minimum spacing (5 nautical miles) and aircraft were launched at one minute intervals, the tenth aircraft would be delayed 9 minutes and the accumulative total delay would be 45 minutes. Since the normal flow restriction is 10 miles in trail for most of these aircraft, the actual delay is much higher.
>
> In the short term, or until the system constraint is removed, it would behoove airlines to consider trading route mileage penalties for ground delay reductions.

The study, therefore, recommended that the airlines "assess the cost of changes in the level and distribution of demand as a basis for reevaluation of airline scheduling policy and/or adoption of quota regulation."

The Task Force did not attempt to quantify the benefits of improvements in airline scheduling, but it concurs in the recommendation of the Tower/Center study.

## Airport Facility Development

**D1—Expand Passenger Terminal Building**
To meet the demands of future traffic growth, the Airport has planned to expand the passenger terminal building so that additional aircraft parking positions and passenger processing facilities would be available. This expansion would entail construction of a southeast concourse connected to a unit terminal east of the existing terminal building.

The Task Force was asked to evaluate possible taxiway congestion on the apron between the existing east concourse and the new facilities.

The results of the simulation experiments show that taxiway congestion would be reduced if the terminal expansion was completed for the post-1985 period. With the existing terminal, the number of aircraft that have to be held and have to wait for a vacant gate during peak periods is estimated to be seven with an average gate delay of 20.9 minutes per aircraft.

With the terminal expansion, this gate delay would not occur, at least in the post-1985 period. As demand increases to the level of that forecast for the post-1990 period, two aircraft would be delayed during the peak period because gate positions were not available, and the average gate congestion was estimated to be about 12.5 minutes per aircraft.

The Task Force recommends that additional terminal building and related facilities be developed as needed to improve the efficiency of Airport operations.

**D2—Relocate Midcoast Aviation**
As future terminal expansion plans are implemented, pressures for the use of the land where Midcoast Aviation is now located will increase, and the Airport will have to consider relocating the facility. In addition to providing land for terminal expansion, the relocation of Midcoast Aviation would relieve some taxiway congestion and would separate general aviation from the heavy air carrier activity on the south side of the Airport.

The Task Force recommends that moving of the Midcoast operation to the NE airport quadrant should be incorporated in development plans and that a specific relocation schedule be negotiated with the owners.

# Summary Of Technical Studies

The operation of the existing airfield and the potential benefits of the Airport options were assessed in terms of airfield capacity, airfield demand, and average aircraft delays.

Estimates of average aircraft delays are based on the interrelationships between airfield capacity and demand. Various airfield system improvements, ranging from changes in air traffic control procedures to changes in physical facilities and operations can increase airfield capacity and thus reduce delays. Therefore, estimates of aircraft delays permit assessment of the operational feasibility of proposed options.

If a dollar value is attached to each minute of average aircraft delay, the cost of a particular airfield improvement can be weighed against its annual delay savings. An average cost per minute of $20 is used in all Task Force studies. This figure is roughly equivalent to actual costs experienced at St. Louis. Thus, a comparison of the costs and the delay reduction associated with each of the various improvements indicates their relative effectiveness. For a given forecast increase in demand, a suitable combination of airfield improvements can be implemented in stages so that airfield capacity is increased as needed and average aircraft delays are maintained within acceptable limits.

The following paragraphs summarize the technical studies. First, present-day runway use at the Airport is briefly described. Then, estimates of present and projected airfield demand, airfield capacity, and average aircraft delay are presented. Next, the airfield capacity increases and the aircraft delay reductions associated with the Airport options are illustrated.

## Runway Configurations

Table 2 illustrates the runway configurations used at the Airport and presents the average percentage utilization of these configurations in different weather conditions. As indicated, use of the parallel runways (12L and 12R or 30L and 30R) is the predominant use pattern during all types of weather.

## Airfield Demand

Table 3 presents the forecasts of airfield demand used in the Task Force study. As indicated, total aircraft operations are forecast to increase from 336,178 in 1979 to 344,000 in the post-1985 time period and 374,000 in the post-1990 time period.

**Table 2**

**RUNWAY USE**
**Lambert-St. Louis International Airport**

| | Runway use | | Percentage use (1978) | | | | |
|---|---|---|---|---|---|---|---|
| **Number** | **Arrival** | **Departure** | **VFR1** | **VFR2** | **IFR1** | **IFR2/3** | **Total** |
| 1 | 12R, 12L | 12R, 12L | 45.0 | 30.6 | 41.8 | 23.9 | 43.7 |
| 2 | 30R, 30L | 30R, 30L | 53.0 | 66.7 | 56.7 | 74.1 | 54.3 |
| 3 | 3OR, 30L, 24 | 30R, 30L | 0.7 | 0.6 | 0.5 | 0.3 | 0.6 |
| 4 | 12R, 12L | 12R, 12L, 6 | 0.3 | 0.5 | 0.2 | 0.2 | 0.3 |
| 5 | 24 | 24 | 0.7 | 1.3 | 0.6 | 1.4 | 0.8 |
| 6 | 12R, 12L, 17 | 12R, 12L | 0.3 | 0.3 | 0.2 | 0.1 | 0.3 |
| Total | | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

**Weather Definitions:**

| **Weather** | **Visibility/ceiling** | **Percentage occurrence** |
|---|---|---|
| VFR1 | Better than 4 miles and 2,500 feet | 83.0% |
| VFR2 | Between 3 miles and 1,000 feet and 4 miles and 2,500 feet | 8.0 |
| IFR1 | Between 2 miles and 800 feet and 3 miles and/or 1,000 feet | 3.6 |
| IFR2/3 | Between 2 miles and/or 800 feet, and above operating minimums | 5.4 |

## Table 3

### FORECASTS OF AIRCRAFT OPERATIONS
### Lambert-St Louis International Airport

Table 3 shows that the heavy aircraft (Class D) are forecast to increase dramatically in the peak hour—from 2 operations per hour in 1979 to 22 in the post-1990 time period.

| | Actual 1979 | Post-1985 | Post-1990 |
|---|---|---|---|
| Annual forecasts | | | |
| Air Carrier | 202,845 | 220,000 | 250,000 |
| Air taxi | 34,834 | 27,000[a] | 32,000[a] |
| General aviation | 90,797 | 85,000[a] | 80,000[a] |
| Military | 7,702 | 12,000 | 12,000 |
| Total operations | 336,178 | 344,000 | 374,000 |
| Percent of 1979 | 100% | 102% | 111% |
| Peak hour forecasts (VFR)[b] | | | |
| Aircraft class | | | |
| A | 6 | 4 | 3 |
| B | 22 | 21 | 21 |
| C | 51 | 47 | 47 |
| D | 2 | 13 | 22 |
| Total operations | 81 | 85 | 93 |
| Percent of 1979 | 100% | 105% | 115% |

a. Forecast data for air taxi includes only scheduled commuter service. Nonscheduled air taxi forecasts are included in the general aviation category.
b. Average day, peak month (August).

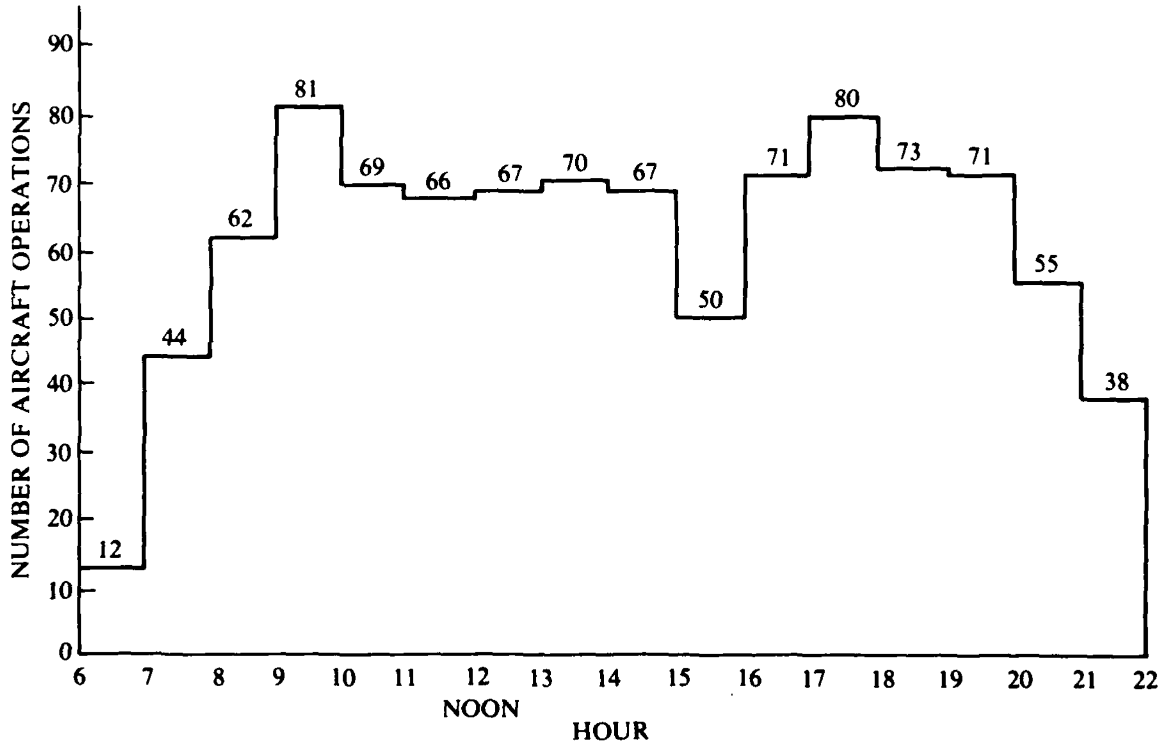
Also crucial to the determination of future delays on the airfield are the forecasts of aircraft mix. Aircraft mix is defined in terms of four classes according to aircraft takeoff weights and performance characteristics. The following tabulation gives the takeoff weights and examples of typical aircraft in each class:

| Aircraft classification | Takeoff weight (pounds) | Types of aircraft |
|---|---|---|
| A | 12,500 or less | Small single-engine aircraft (such as Piper PA-23, Cessna C-180, Cessna C-207) |
| B | 12,500 or less and some Learjets | Small twin-engine aircraft (such as Piper PA-31, Beech GE-55. Cessna C-310, Learjet LR-25) |
| C | 12,500 to 300,000 | Large aircraft (such as Convair CV-580, B-707-120, B-727, DC-9, B-737, B-757) |
| D | 300,000 or more | Heavy aircraft (such as B-747, B-767, DC-10, L-1011, DC-8-62, B-707-300) |

Figure 1 displays the hourly variation in traffic.

**Figure 1**

**HOURLY VARIATION OF TRAFFIC**
**LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT**
**Average day, Peak month 1979**



## Airfield Capacity

Airfield capacity is the maximum number of aircraft operations (landings or takeoffs) that can be processed in a given time under specific conditions of:

- Ceiling and visibility conditions
- Runway layout and use
- Aircraft mix (types of aircraft)
- Percent arrivals

Airfield capacity is normally expressed on an hourly basis. Many factors limit airfield capacity at Lambert, including:

- Proximity of parallel runway sets (ILS approaches to parallel runways are not independent)
- Weather, wind, and visibility limitations (weather anomalies cause frequent changes in runway use and sometimes limit approach to one direction)
- Wake turbulence and the mix of heavy aircraft, as discussed earlier
- Requirement of en route separation (aircraft must be spaced 5 miles in trail when Air *Route Traffic Control* Center assumes control. This requirement causes takeoff delays).
- Airfield maintenance and construction
- Runway and apron congestion
- Placement of general aviation areas
- Effect of Lambert operations on neighboring airports

Table 4 presents airfield capacity estimates for 1979.

**Table 4**
**AIRFIELD CAPACITY**
**Lambert-St. Louis International Airport**
**1979[a]**

| | Runway use[b] | | Hourly capacity (operations/hour) | | | |
|---|---|---|---|---|---|---|
| **Number** | **Arrival** | **Departure** | **VFR1** | **VFR2** | **IFR1** | **IFR2/3** |
| 1 | 12R, 12L | 12R, 12L | 112 | 87 | 63 | 65 |
| 2 | 30R, 30L | 30R, 30L | 112 | 87 | 63 | 65 |
| 3 | 3OR, 30L, 24 | 30R, 30L | 138 | 122 | 93 | n.a. |
| 4 | 12R, 12L | 12R, 12L, 6 | 112 | 87 | 63 | 65 |
| 5 | 24 | 24 | 55 | 55 | 53 | 47 |
| 6 | 12R, 12L, 17 | 12R, 12L | 116 | 93 | 60 | n.a. |

a. Aircraft operations data for 1979 were adjusted to reflect an assumption that the Ozark Air Lines strike of that year did not take place.

b. Runway use shown for VFR conditions.

## Airfield Delays

Airfield delay is the additional travel time, caused by airfield congestion, taken by an aircraft to takeoff or land. Computing average annual airfield delays involves assumptions on:

- Airfield physical characteristics
- Air traffic control systems and procedures
- Aircraft operational characteristics
- Airfield demand
- Weather

Average annual delays are expressed in minutes per aircraft operation.

Congestion results whenever the volume of aircraft operations at an airport approaches or exceeds airfield capacity. Aircraft delay during *heavily congested periods are very high;* consequently, the average aircraft annual delays are also high. Substantial levels of congestion will prevail at Lambert-St. Louis International Airport by 1990 unless airfield improvements and/or changes in air traffic control procedures are implemented to increase its capacity.

Figure 2 illustrates the increases in average annual delay that would occur in the future if the airfield improvement program was not implemented and if no further improvements are implemented. With implementation of the improvements identified in Table 1, average annual delays would be significantly less than those identified in Figure 2, and annual delay cost savings of many millions of dollars could be achieved.

**Figure 2**

**AVERAGE ANNUAL DELAYS, 1979 AIRFIELD LAMBERT—ST. LOUIS INTERNATIONAL AIRPORT (No further improvements)**

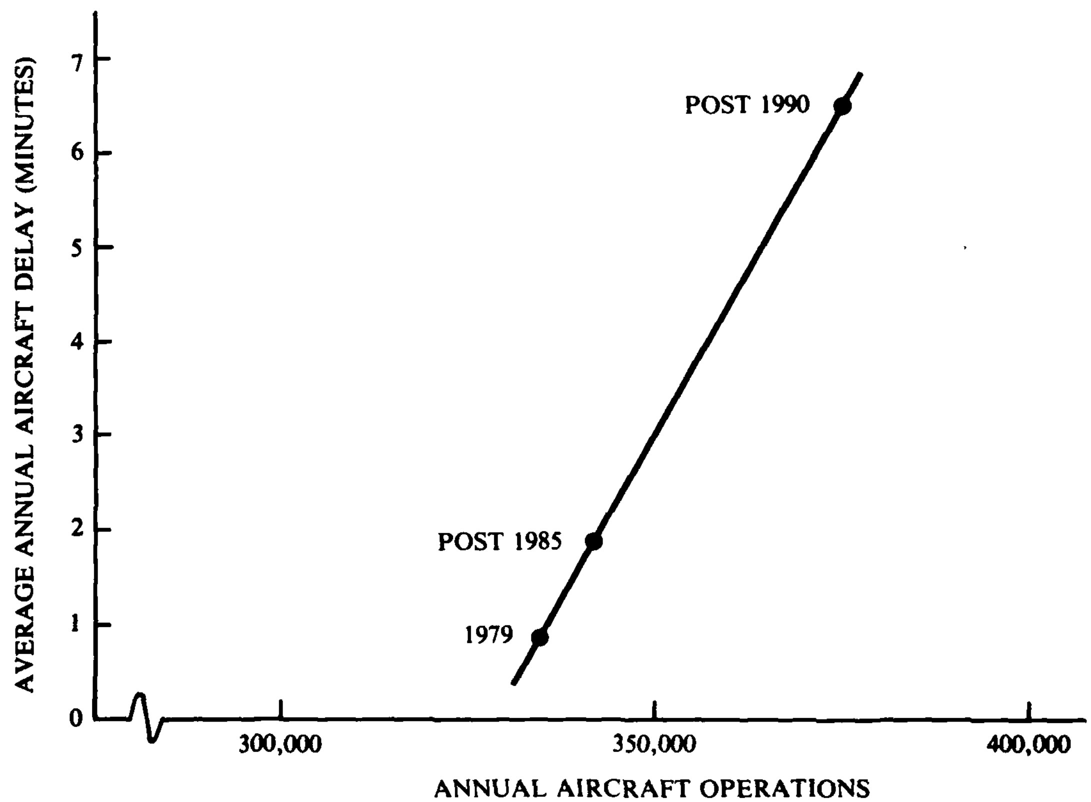


Table 4 present airfield capacity estimates for 1979.

## Action Plan

Implementing the results of this Task Force study will be accomplished in the short range time frame (up to 1985) or in the intermediate range (1985 to 1990). Agencies responsible for implementation include the FAA, the airlines, and the St. Louis Airport Authority ("City"). Table 5 shows the recommended action plan for implementation.

### Table 5
### ACTION PLAN

| | | Time frame | | Lead agencies | | |
|---|---|---|---|---|---|---|
| Number | Improvement | Short range | Intermediate range | FAA | Airlines | City |
| A1 | Airfield Development program | Under construction | | ● | | ● |
| B1 | Localizer directional aid | ●[1] | | ● | ● | |
| B2 | Runways 24, 30L, and 30R | ●[2] | | ● | ● | |
| B3 | Departure fanning | ●[2] | | ● | ● | ● |
| B4 | Future ATC systems | | ● | ● | | |
| B5 | Improve Center/Tower operations | ●[3] | ● | ● | | |
| C1 | Increase heavy jets | | ● | | ● | |
| C2 | Decrease general aviation | | ● | | | ● |
| C3 | Improve airline scheduling | ● | | | ● | |
| D1 | Expand passenger terminal | | ● | | ● | ● |
| D2 | Relocate Midcoast Aviation | | ● | | ● | ● |

[1] R12L approach has been commissioned.
[2] Has been partially implemented during construction period.
[3] All improvements immediately implementable have been adopted.